Exploring the Potential for Forest Carbon Management in Northeastern Forests: a Research Synthesis

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Exploring the Potential for Forest Carbon Management in Northeastern Forests: a Research Synthesis

- Carbon silviculture – Jared Nunery MS Thesis
- Prospects for rehabilitation silviculture – Emily Russell-Roy MS Thesis
- Factors influencing carbon project financial viability – Charles Kerchner PhD Dissertation

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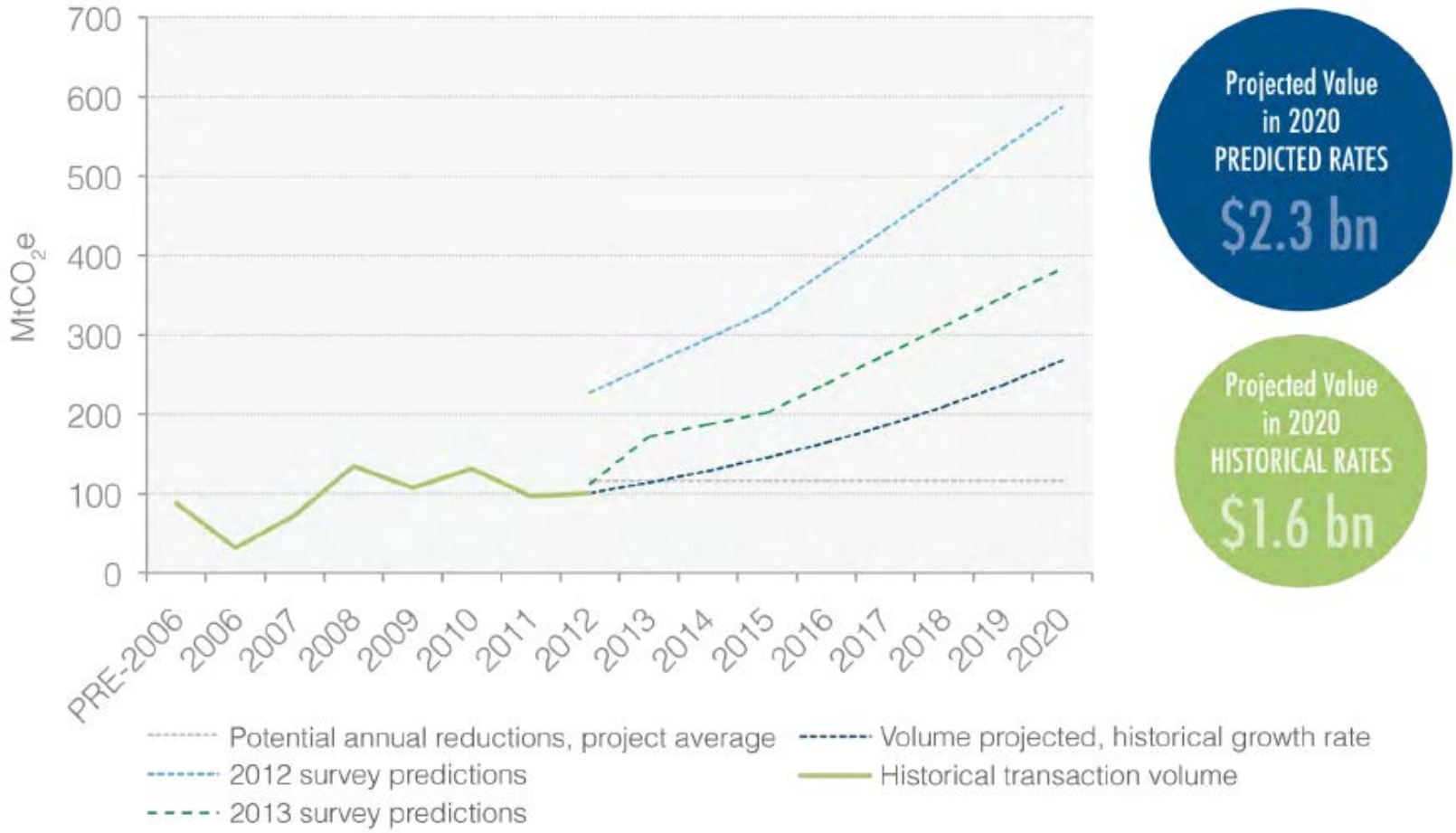
Historic and projected trends in the voluntary carbon offset markets



Notes: Based on 87 organization responses.
Source: Forest Trends' Ecosystem Marketplace. State of the Voluntary Carbon Markets 2013.

“Best” Carbon Market Options for the Forest Sector in the Northeast

→ Improved Forest Management

→ Avoided Conversion

1. California Compliance Market (ARB)
2. Verified Carbon Market (VCS)

- Reduced Impact Logging (RIL)
- Logged to Protected Forests (LtPF)
- Low to Highly Productive Forests (LtPH)
- Extended Rotation Age (ERA)
- Others to be developed

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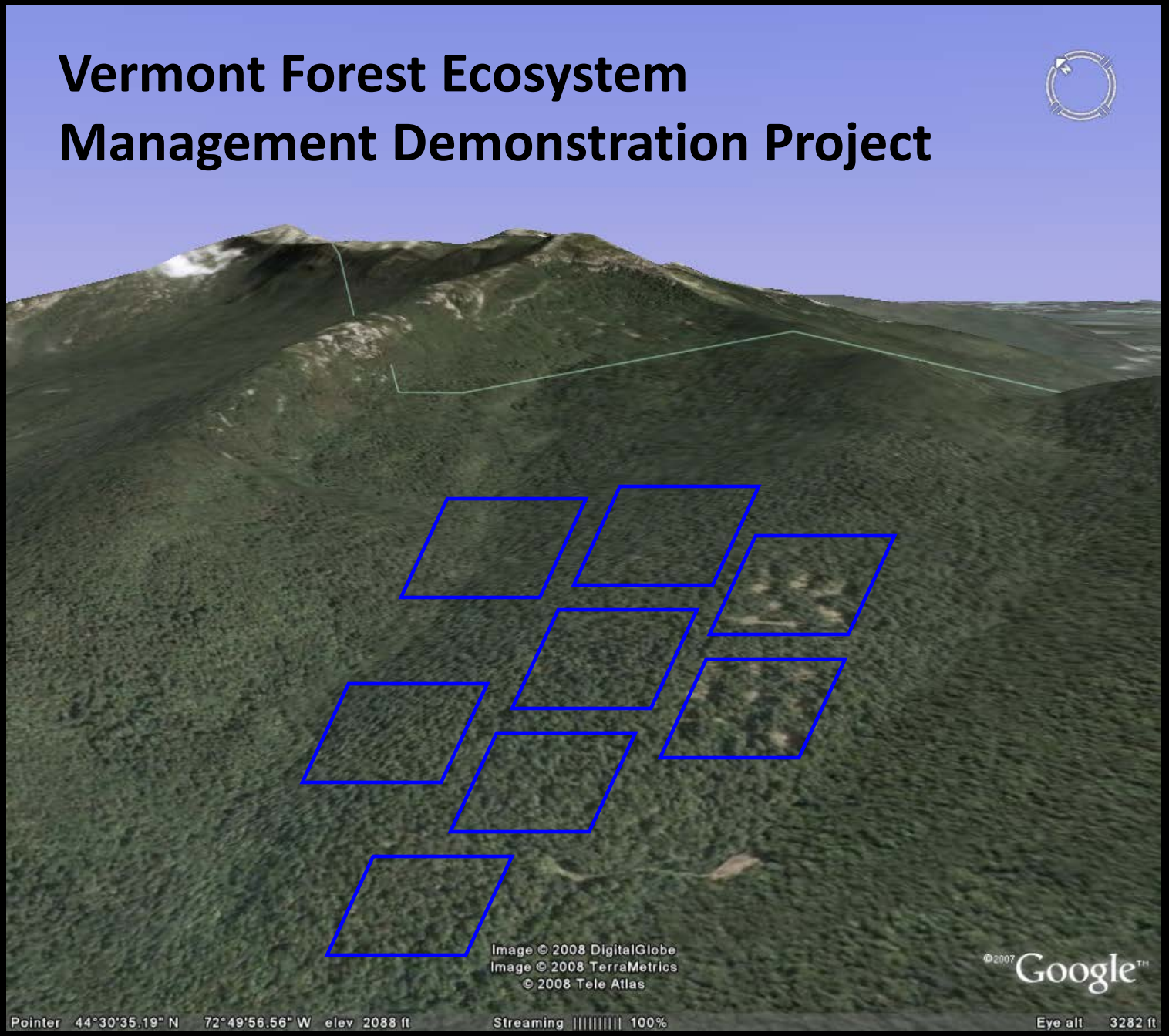
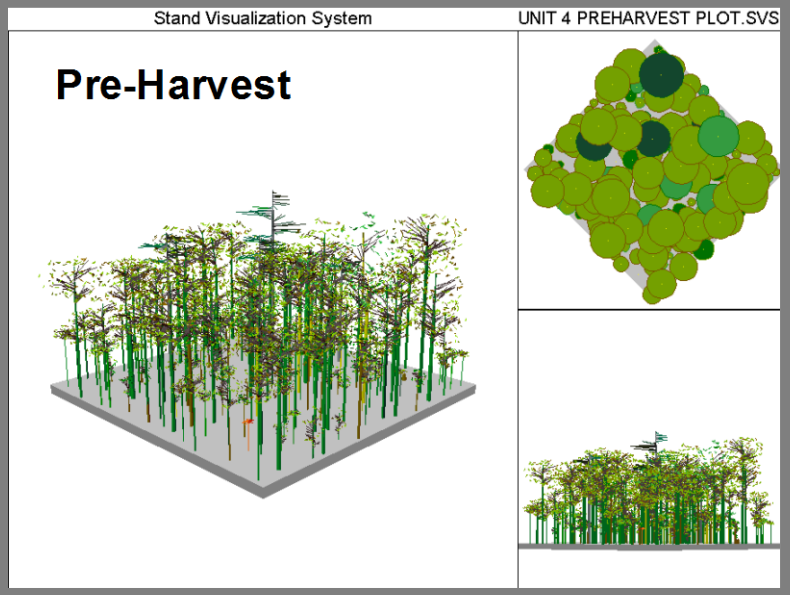
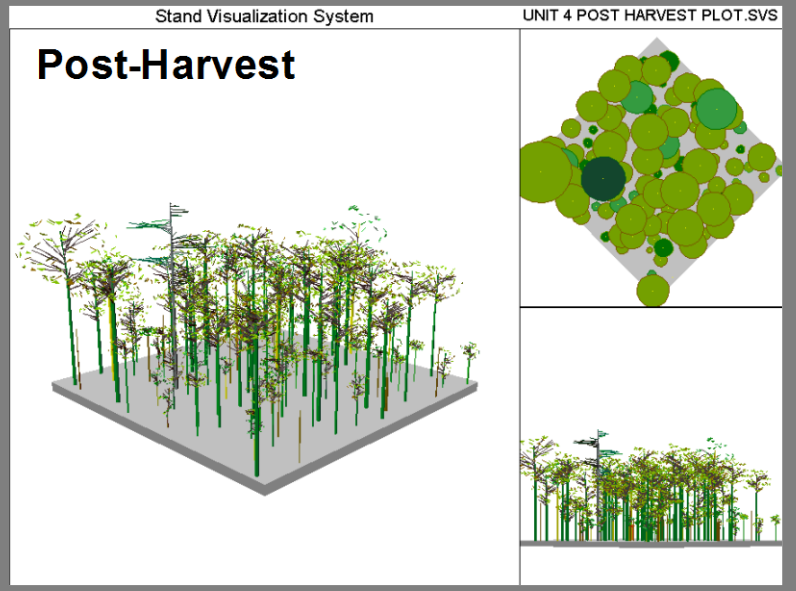
Vermont Forest Ecosystem Management Demonstration Project

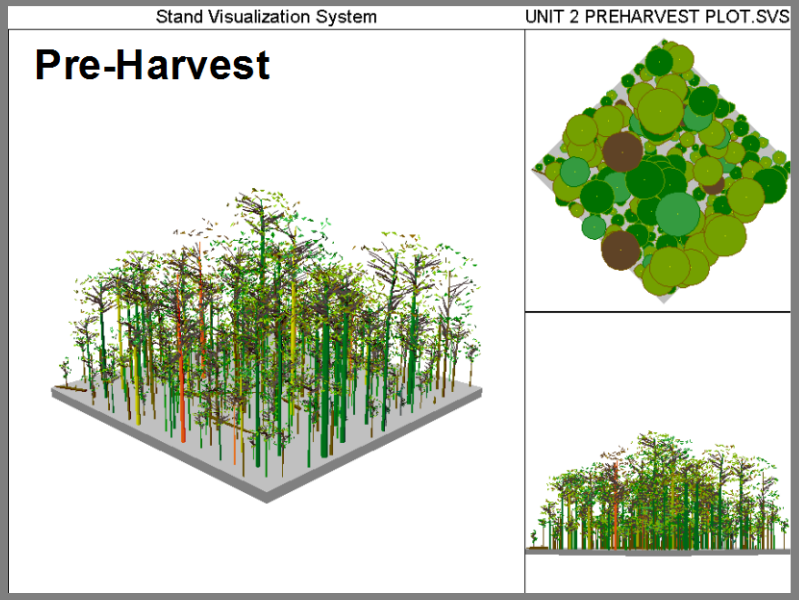


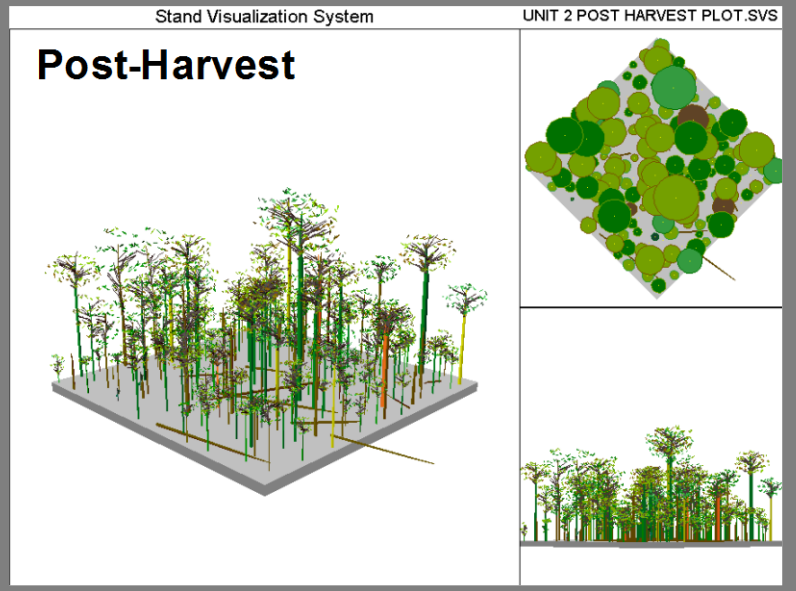
Single-Tree Selection Unit



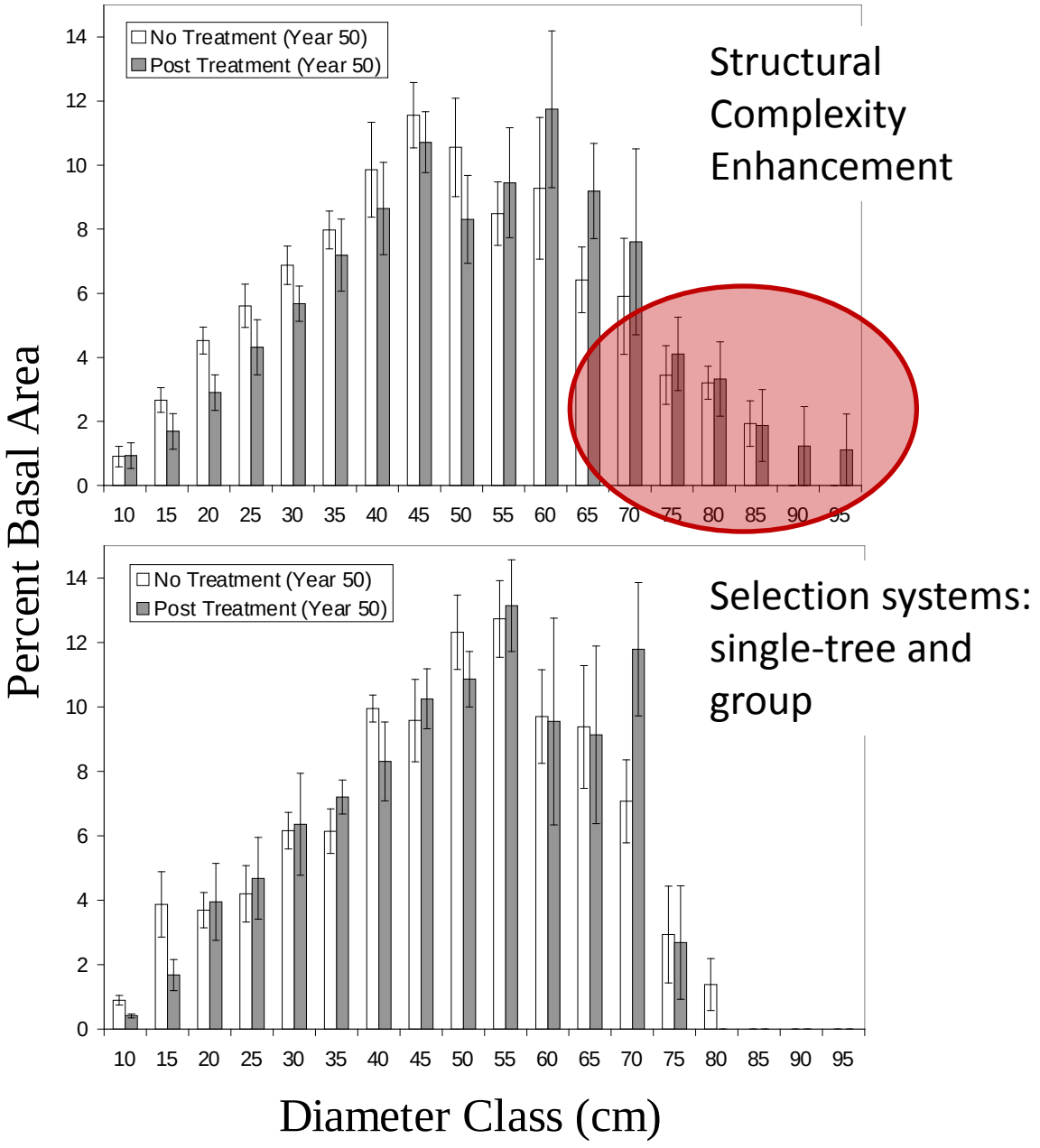


Structural Complexity Enhancement Unit





Basal Area Allocation Projected to Year 50



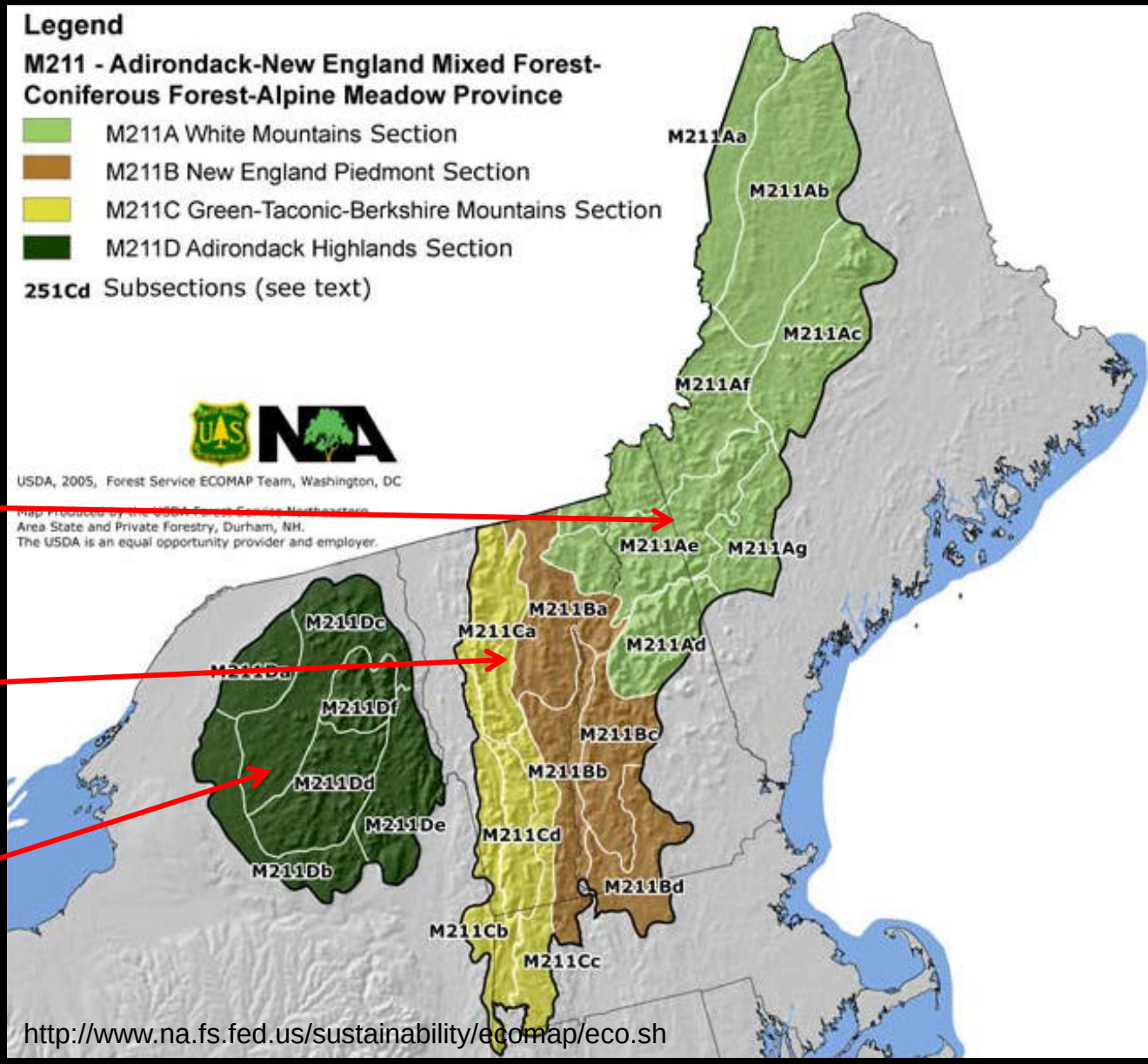
Stratified random sample of FIA sites

32 stands from the Northern Forest Region

14 stands from the White Mountains and western Maine

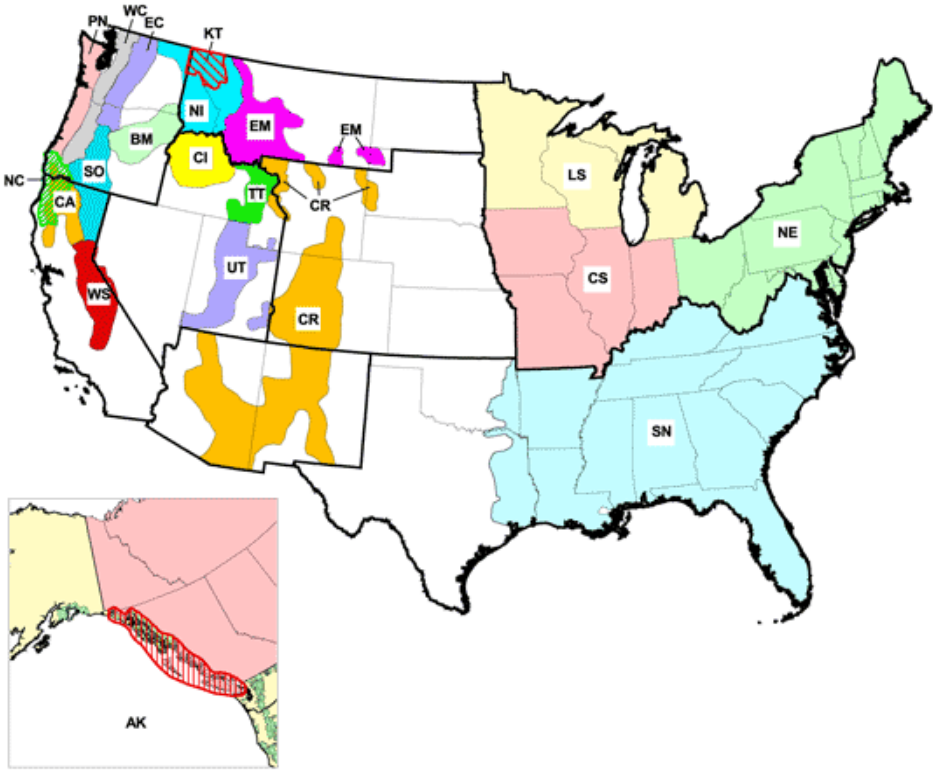
3 stands from the Green Mountain Region

15 stands from the Adirondack Region



Forest Vegetation Simulator

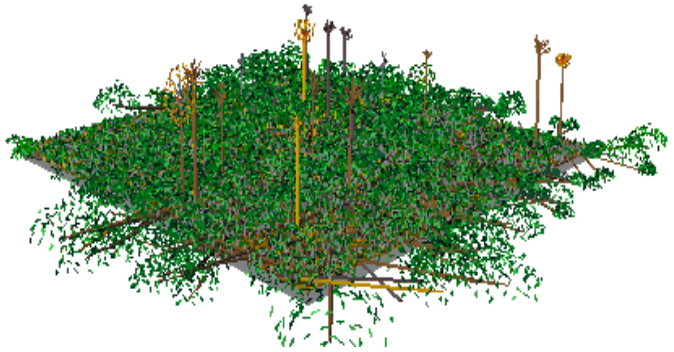
- An individual tree-based, spatially independent model
- Uses regional growth and yield equations
- Mortality f(density)
- Requires regeneration parameterization
- Designed for both even and uneven aged stands of mixed species composition
- Carbon estimates derived allometrically
- Wood products life cycle and carbon residency based on US Forest Service (2006)



http://www.fs.fed.us/fmsc/fvs/variants/index.shtml

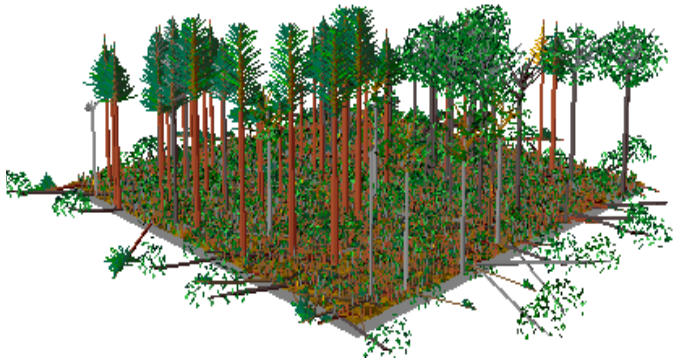
Management scenarios

Clearcut Variants



(2)

Shelterwood Variants



(2)

Selection System Variants

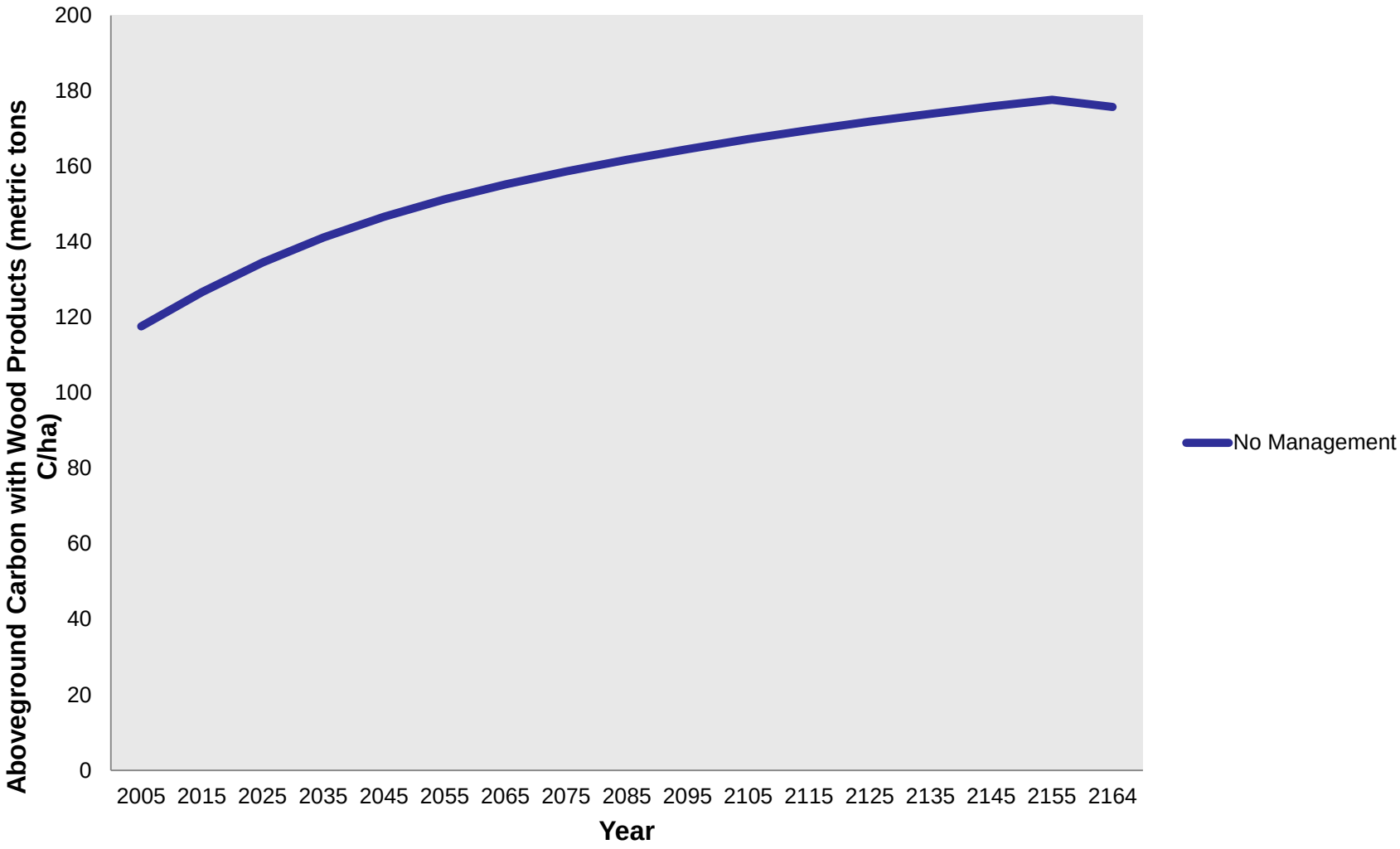
(4)

8 active management scenarios, varying harvesting intensity and frequency

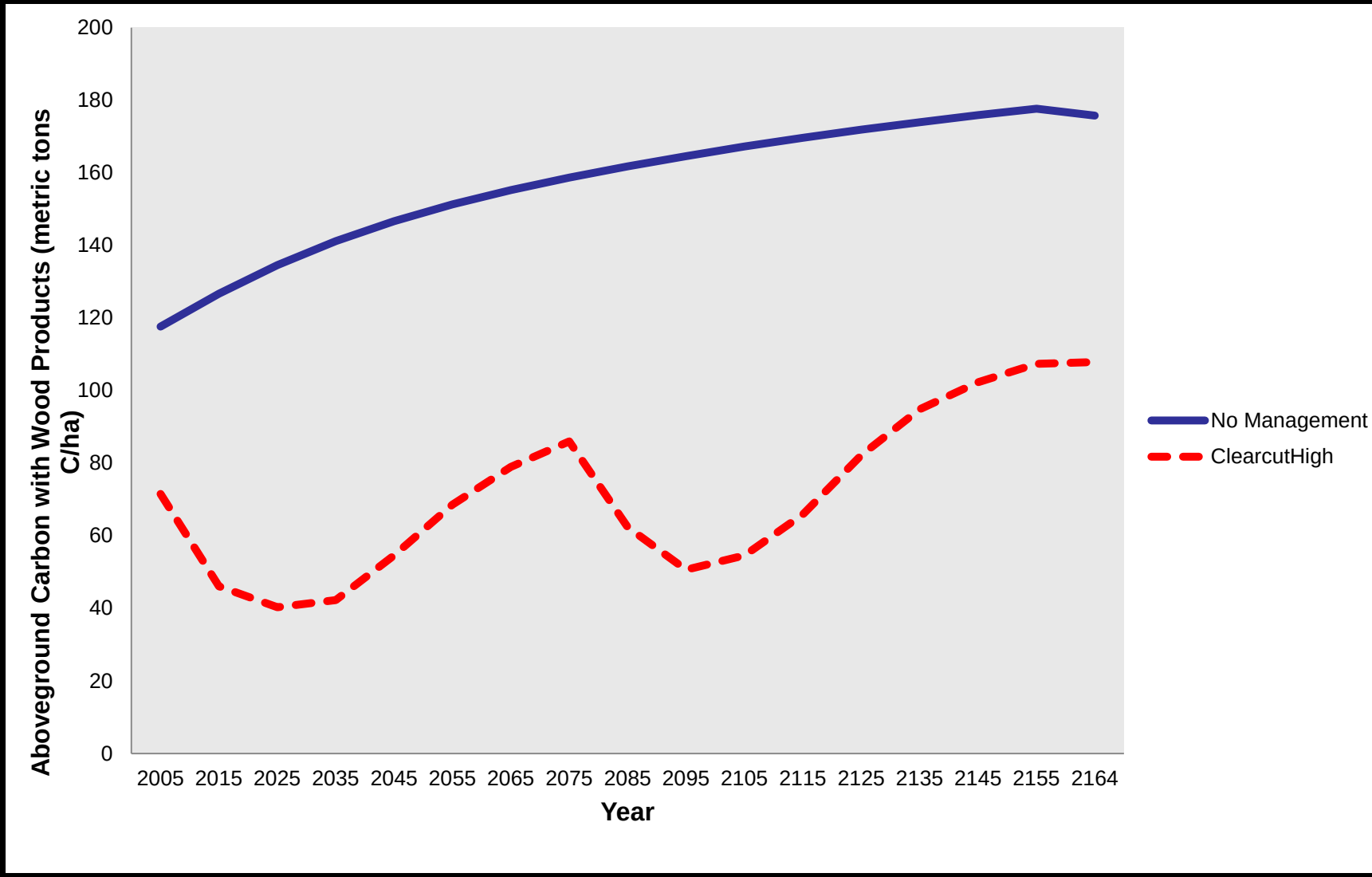
Even-aged Silvicultural Prescriptions		Rotation Length	
		Short (80 years)	**Long (120 years)**
Residual Structure	**Low**	1) Commercial thin: implement when stand reaches stocking density above normal. 2) **Clearcut: 2005 and 2085** -No legacy trees *Whole tree harvest	1) Commercial thin: implement when stand reaches stocking density above normal. 2) **Clearcut: 2005 and 2125** -No legacy trees. *Whole tree harvest
	High	1) Commercial thin: implement when stand reaches stocking density above normal. 2) **Shelterwood: 2005 and 2085** -residual BA 60ft^2/ac -15 legacy TPA, smallest diameter in removal cut 6 in *Slash left on site	1) Commercial thin: implement when stand reaches stocking density above normal. 2) **Shelterwood: 2005 and 2125** -residual BA 60ft^2/ac -15 legacy TPA, smallest diameter in removal cut 6 in. *Slash left on site

Uneven-aged Silvicultural Prescriptions		Entry Cycle Length	
		Short (15 years)	Long (30 years)
Residual Structure	Low	Entry Cycle Length: 15 yrs Q-value: 1.3 Residual BA: 65 ft^2/ac Min DBH Class: 2 in Max DBH Class: 20 in DBH Class Width: 2 in Number of Legacy TPA: 0	Entry Cycle Length: 30 yrs Q-value: 1.3 Residual BA: 65 ft^2/ac Min DBH Class: 2 in Max DBH Class: 20 in DBH Class Width: 2 in Number of Legacy TPA: 0
	High	Entry Cycle Length: 15 yrs Q-value: 1.3 Residual BA: 85 ft^2/ac Min DBH Class: 2 in Max DBH Class: 24 in DBH Class Width: 2 in Number of Legacy TPA: 5 Average legacy tree diameter: 16 in	Entry Cycle Length: 30 yrs Q-value: 1.3 Residual BA: 85 ft^2/ac Min DBH Class: 2 in Max DBH Class: 24 in DBH Class Width: 2 in Number of Legacy TPA: 5 Average legacy tree diameter: 16 in

Model Predictions



Model Predictions



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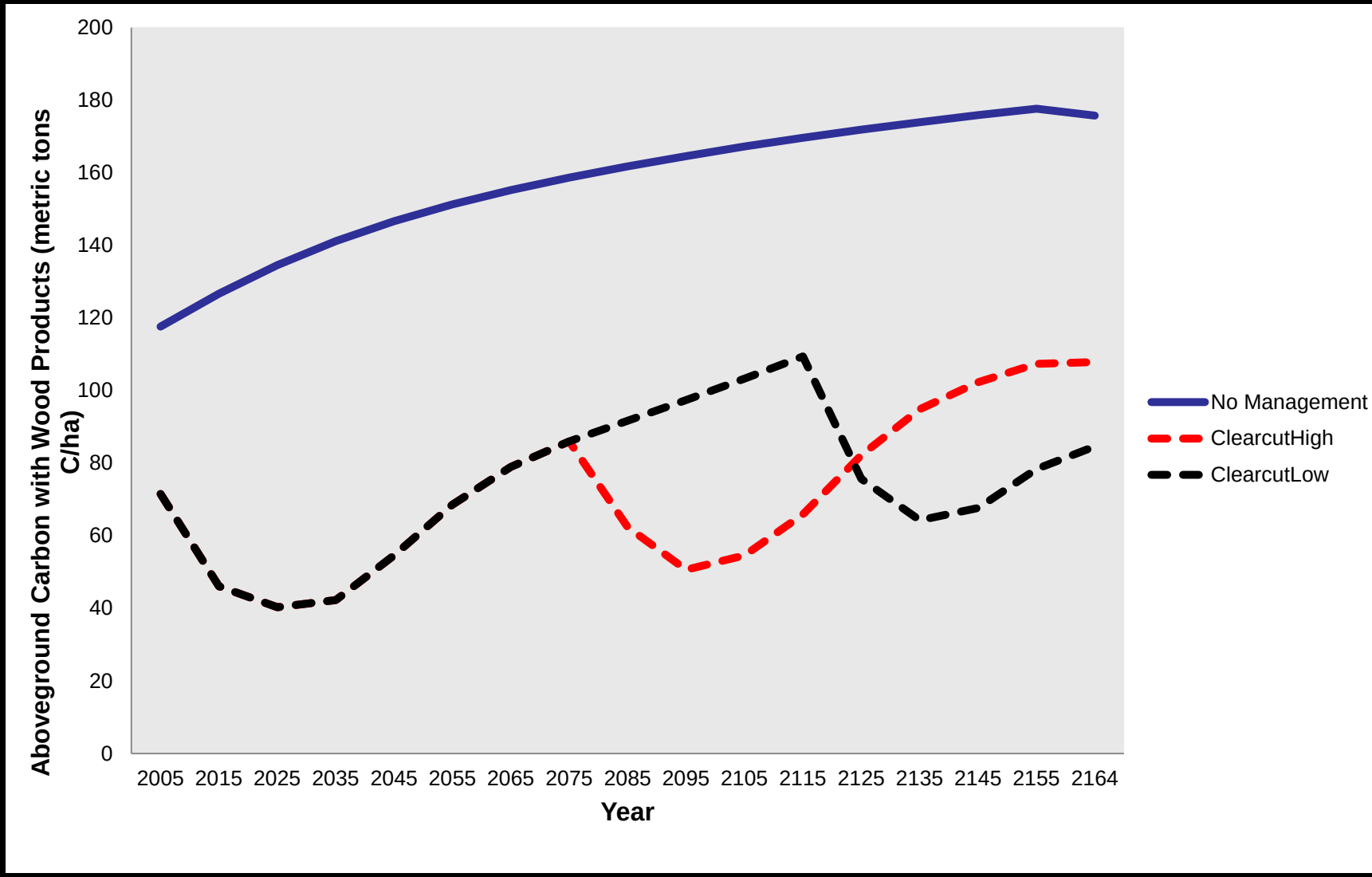

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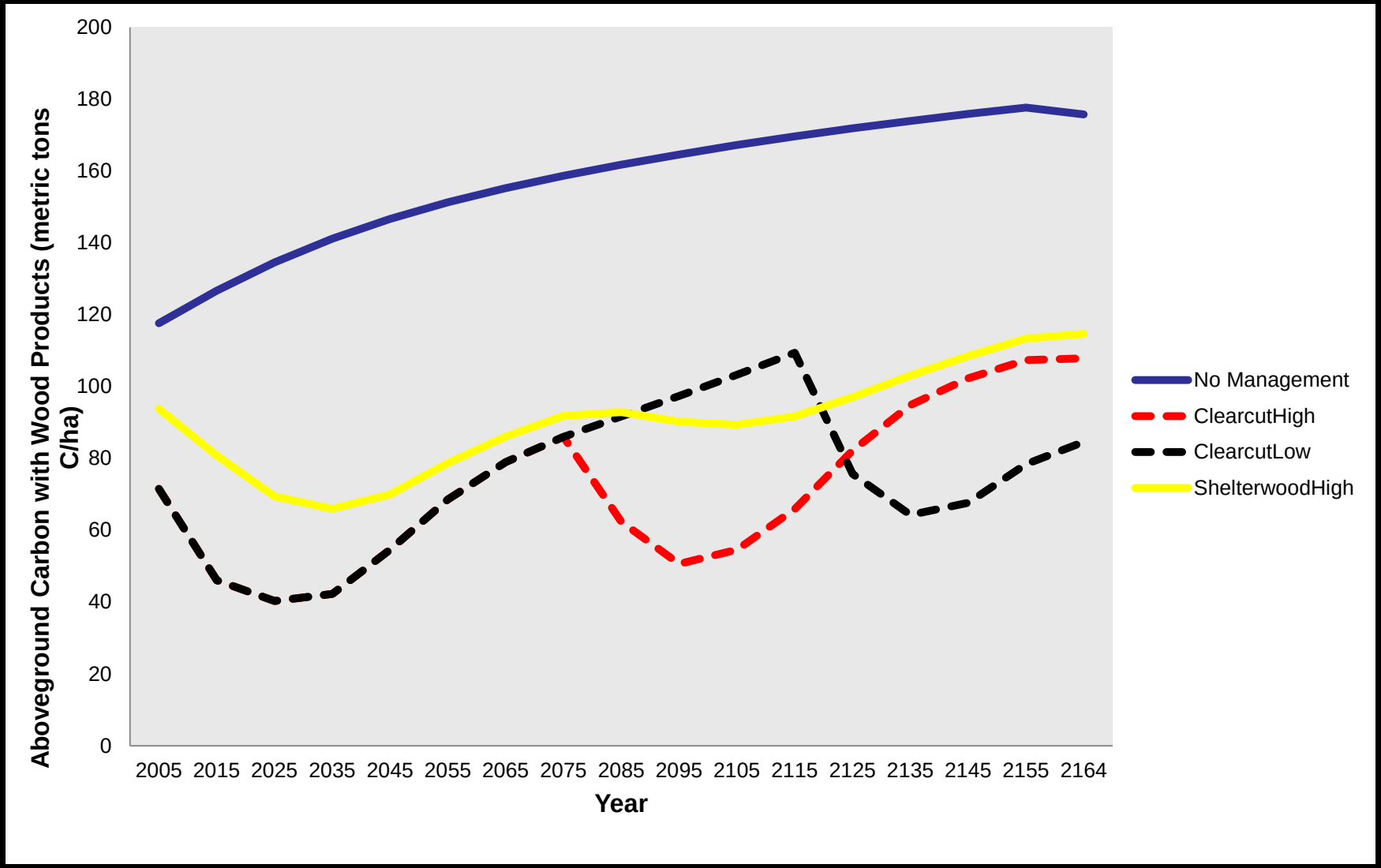
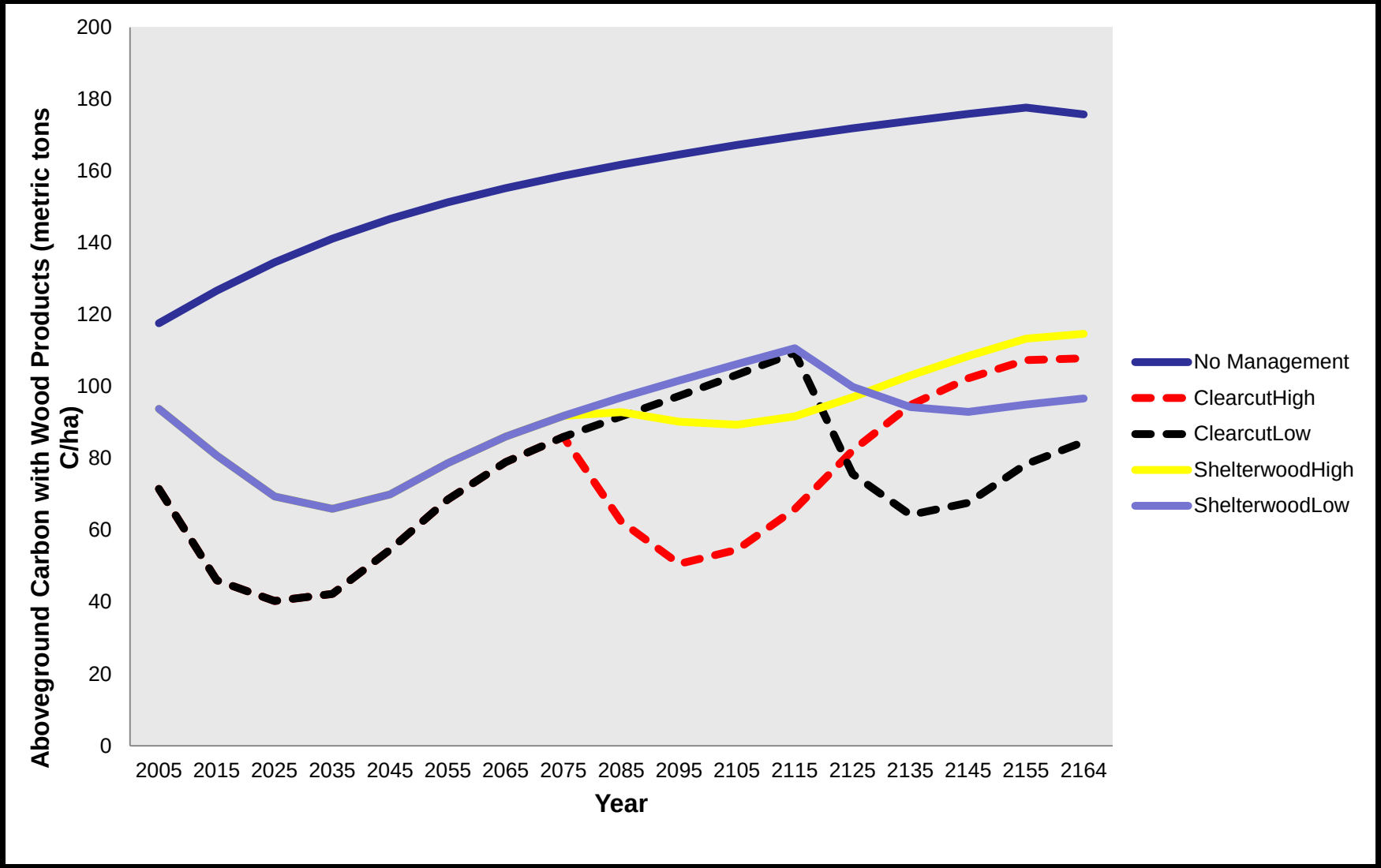


Model Predictions



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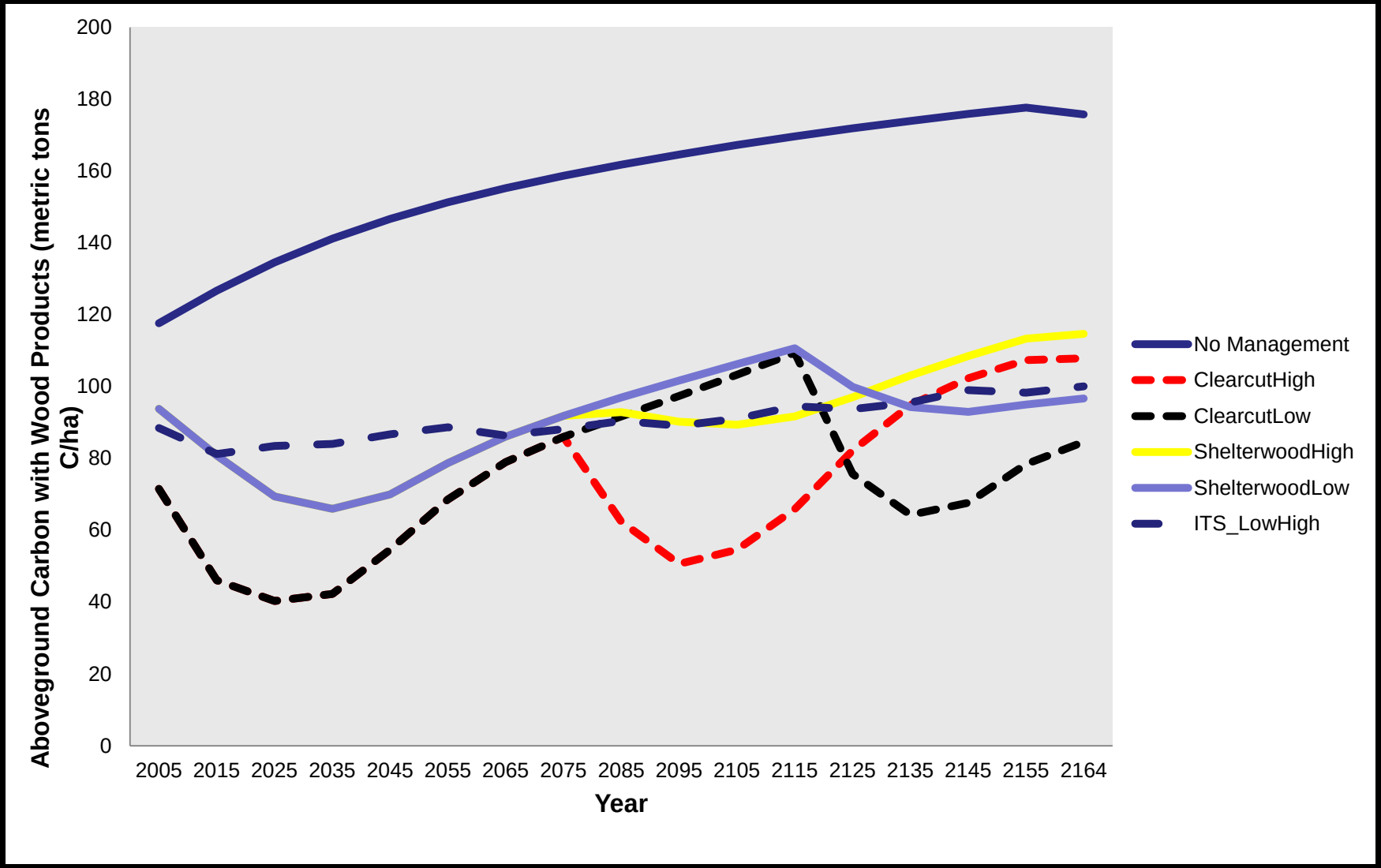

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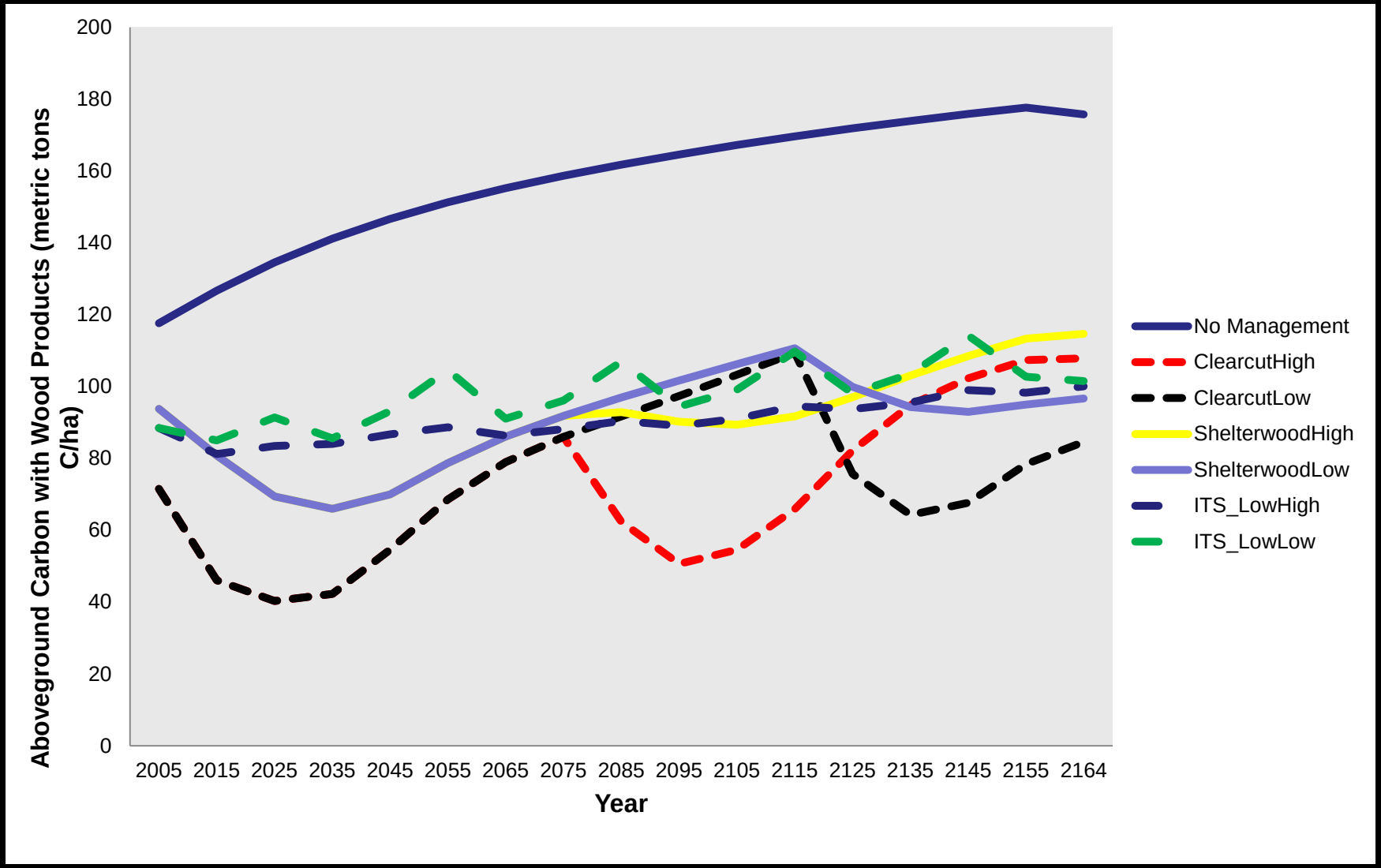

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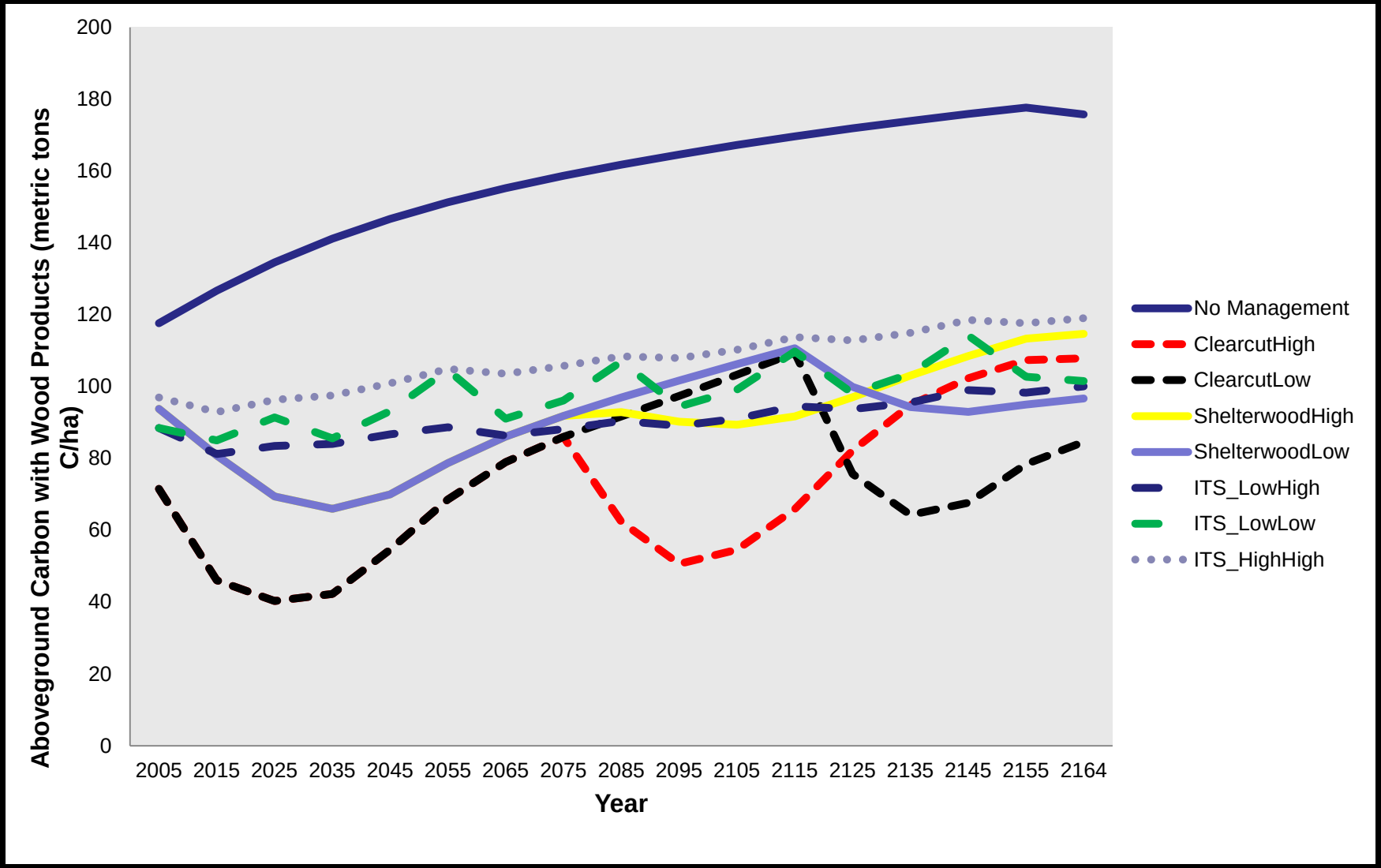

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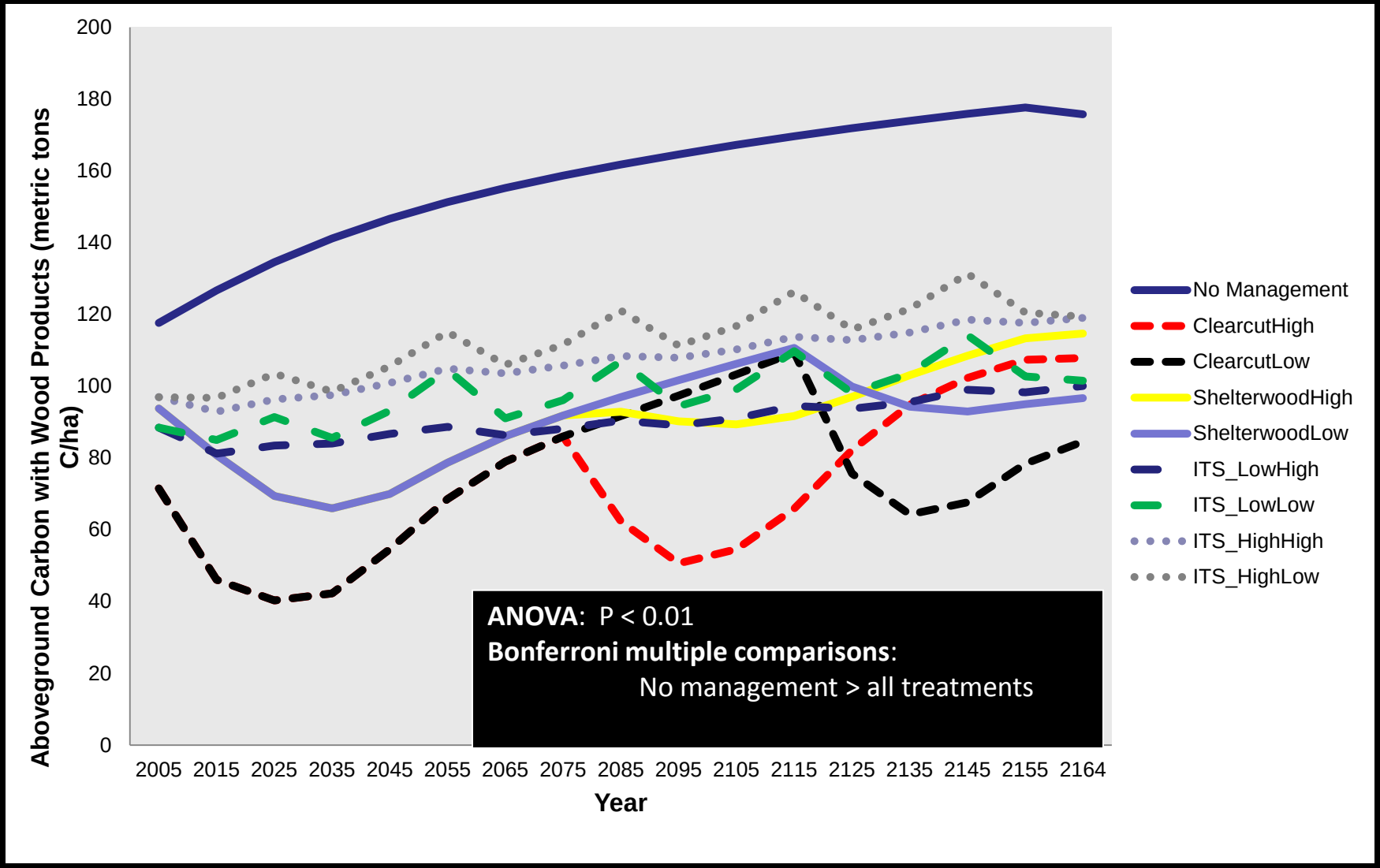
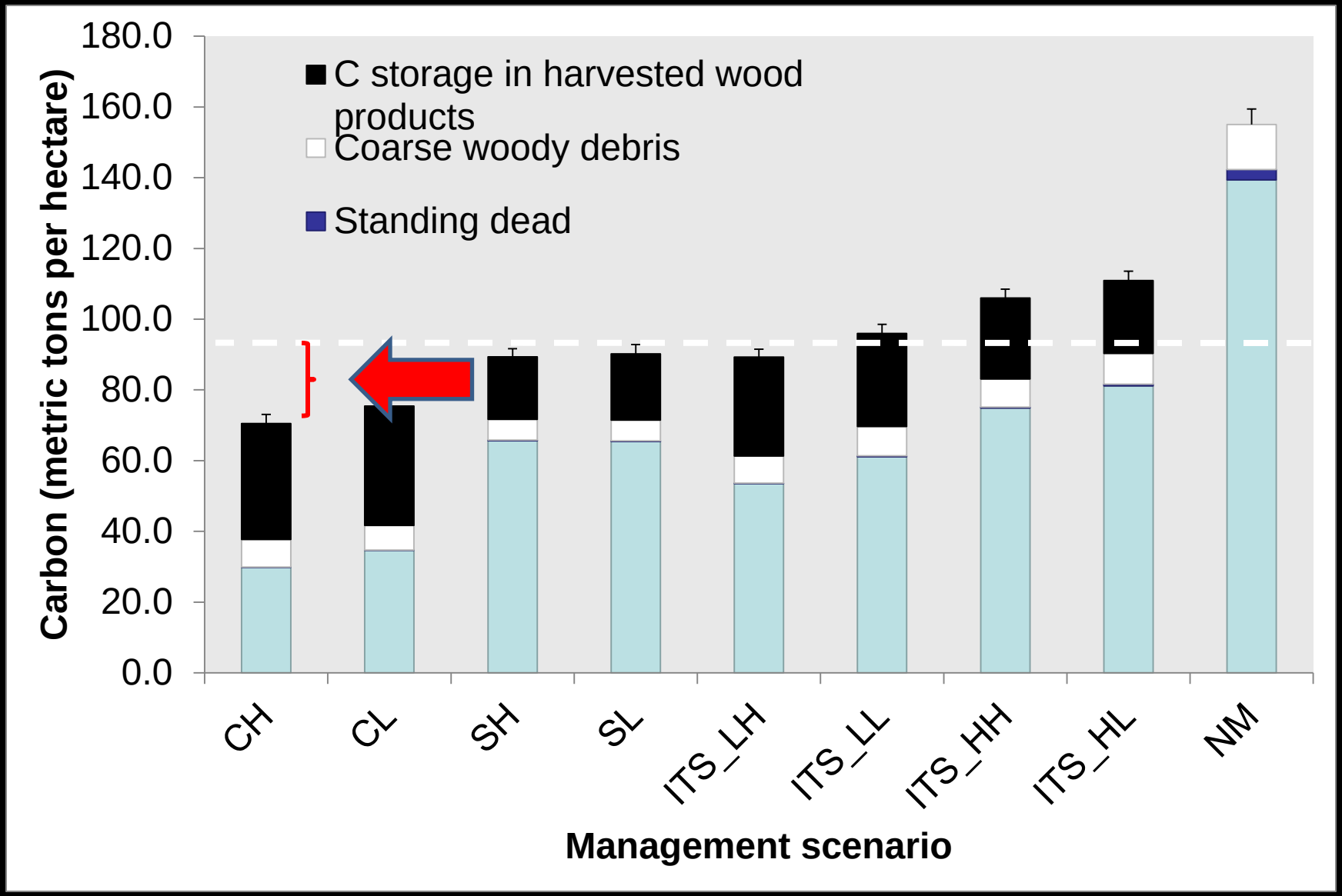


Model Predictions



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Research Question

1) What rehabilitation scenarios perform best, integrating carbon credits and timber?

2) Can carbon markets help to incentivize rehabilitation efforts on poorly stocked timberlands?

VCS VERIFIED CARBON STANDARD

CLIMATE ACTION RESERVE

American Carbon Registry

California Environmental Protection Agency
Air Resources Board

Study Area

Source: Conservation Collaboratives, 2008

- Privately owned
- High-graded in the past by former landowner

- 391 hectares of former industrial timberland
- Predominantly northern hardwood species

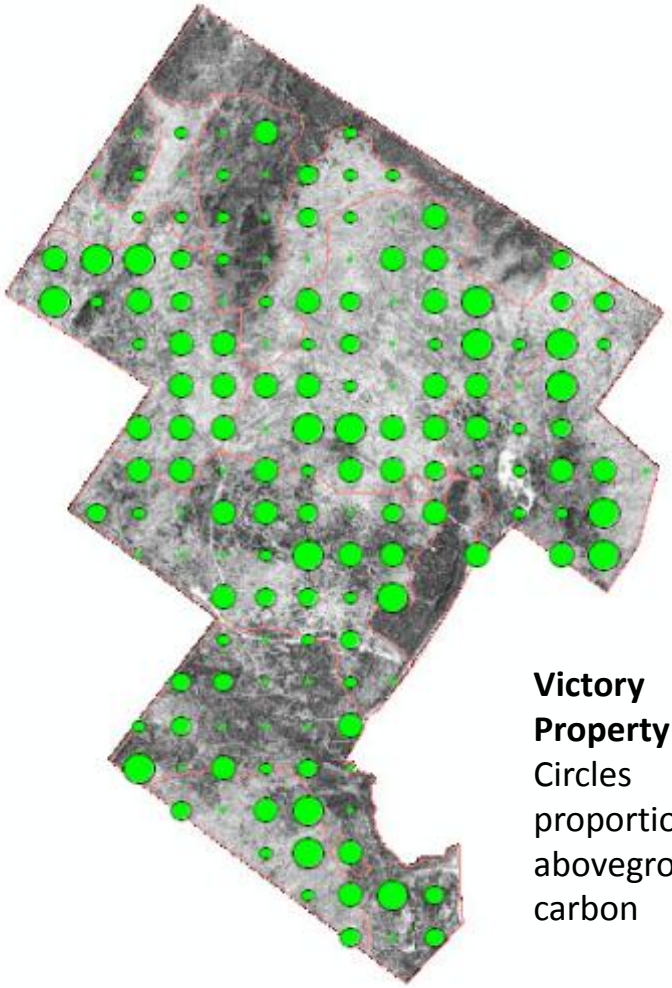
Methods

Inventory:

- 157 prism plots (BAF 10)
- Systematic sample on grid
- Subsampling of tree heights for biomass estimates

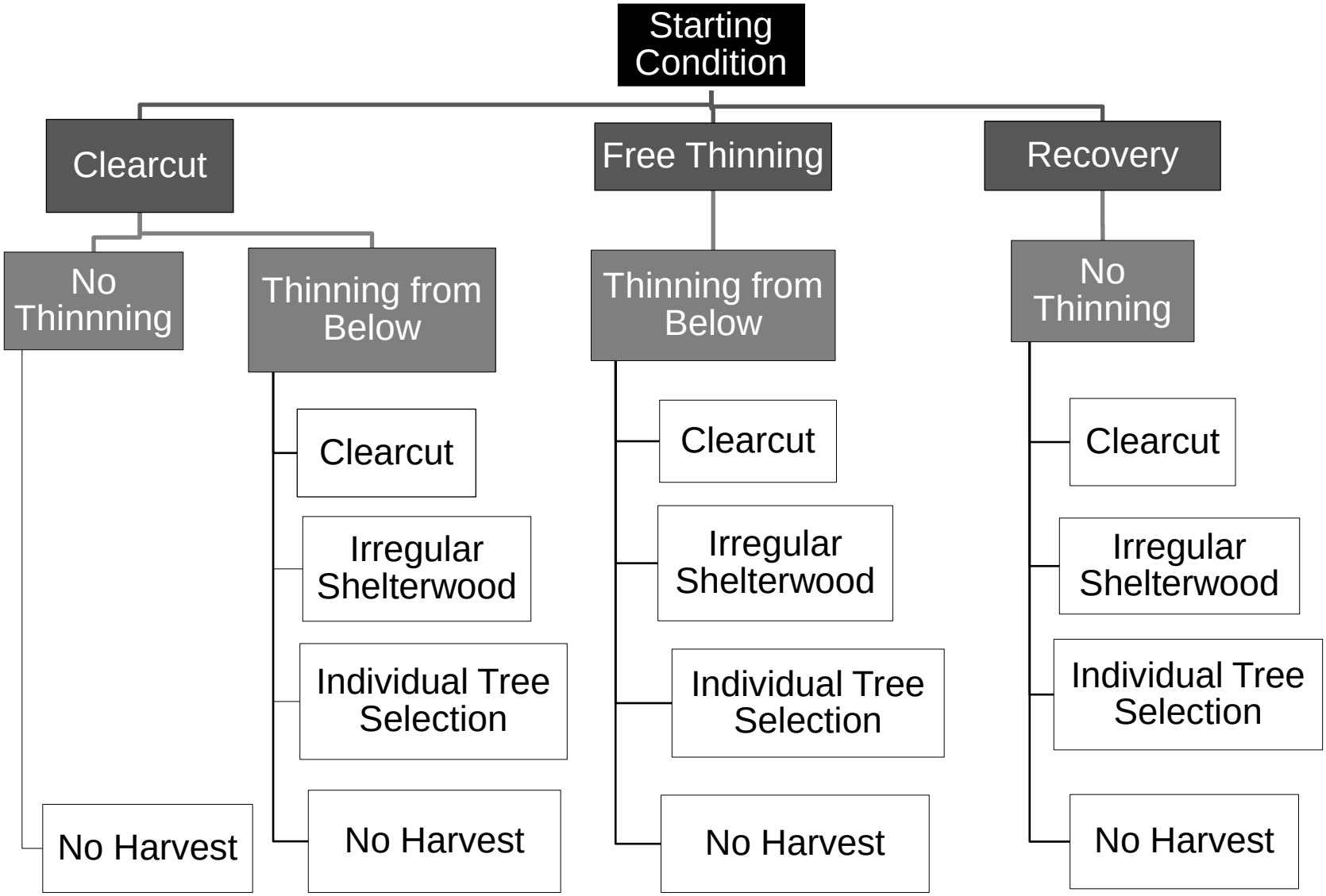
Modeling:

- NE-FVS (Forest Vegetation Simulator)
- 100 year simulations
- Fire & Fuels Extension to calculate C
- Regeneration inputs
- Limited by model uncertainty; not spatially explicit
- Doesn't account for stem form or quality



Victory Property: Circles proportionate to aboveground carbon

Rehabilitation Scenarios



Carbon Markets

- **Calculated credits from different offset protocols**
  - American Carbon Registry (ACR)
  - Climate Action Reserve (CAR)

- **Evaluated economic feasibility of offset project**

Costs

- Project development
- Annual monitoring
- 3rd party verification
- Management costs

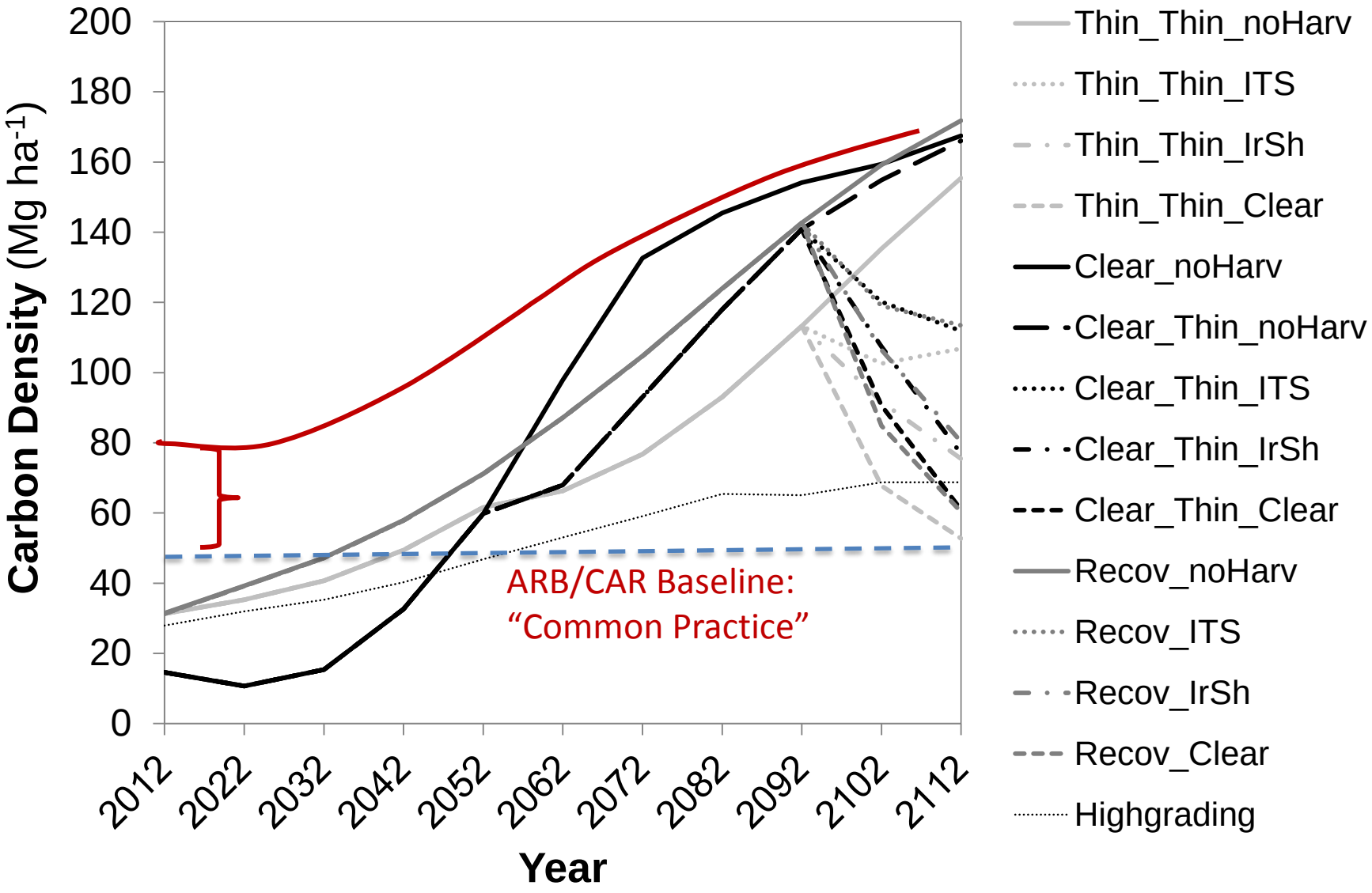
Revenues

- Low voluntary market ($8.50, $10, $12)
- High voluntary market ($10, $15, $30)
- Regulatory market ($11, $26, $50)
- Timber sales (sawlog and pulpwood)

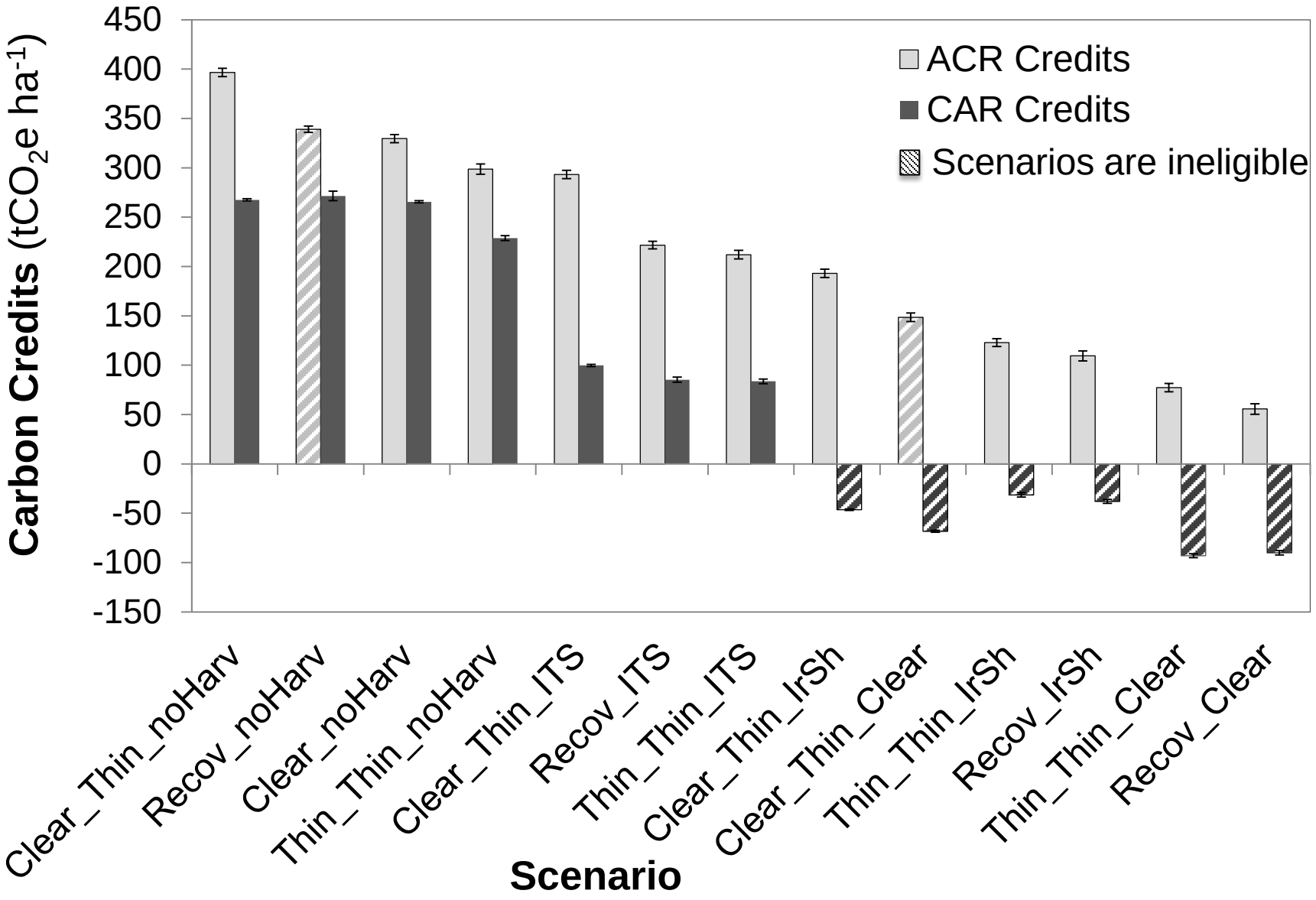
Deductions required by CAR and ACR

Deductions	American Carbon Registry	Climate Action Reserve
Uncertainty	0%-20%	5%
Risk of Reversal/ Buffer Pool Contribution	15%	19%
Activity-shifting Leakage	None assumed since project must be certified	20% of the difference between actual and baseline carbon
Market Leakage	0%-40%	20% of the difference between actual and baseline carbon

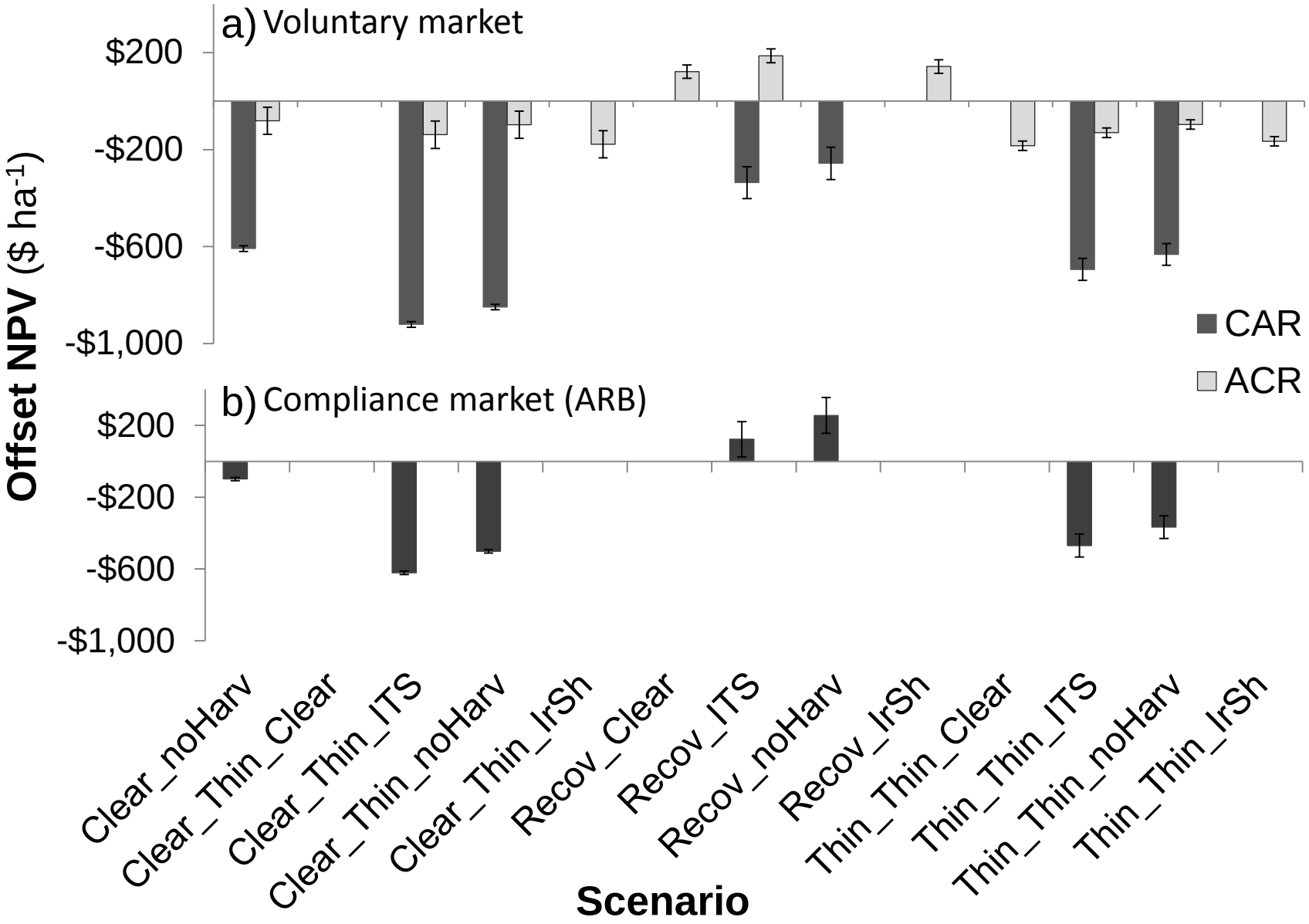
Carbon Stock Accumulation



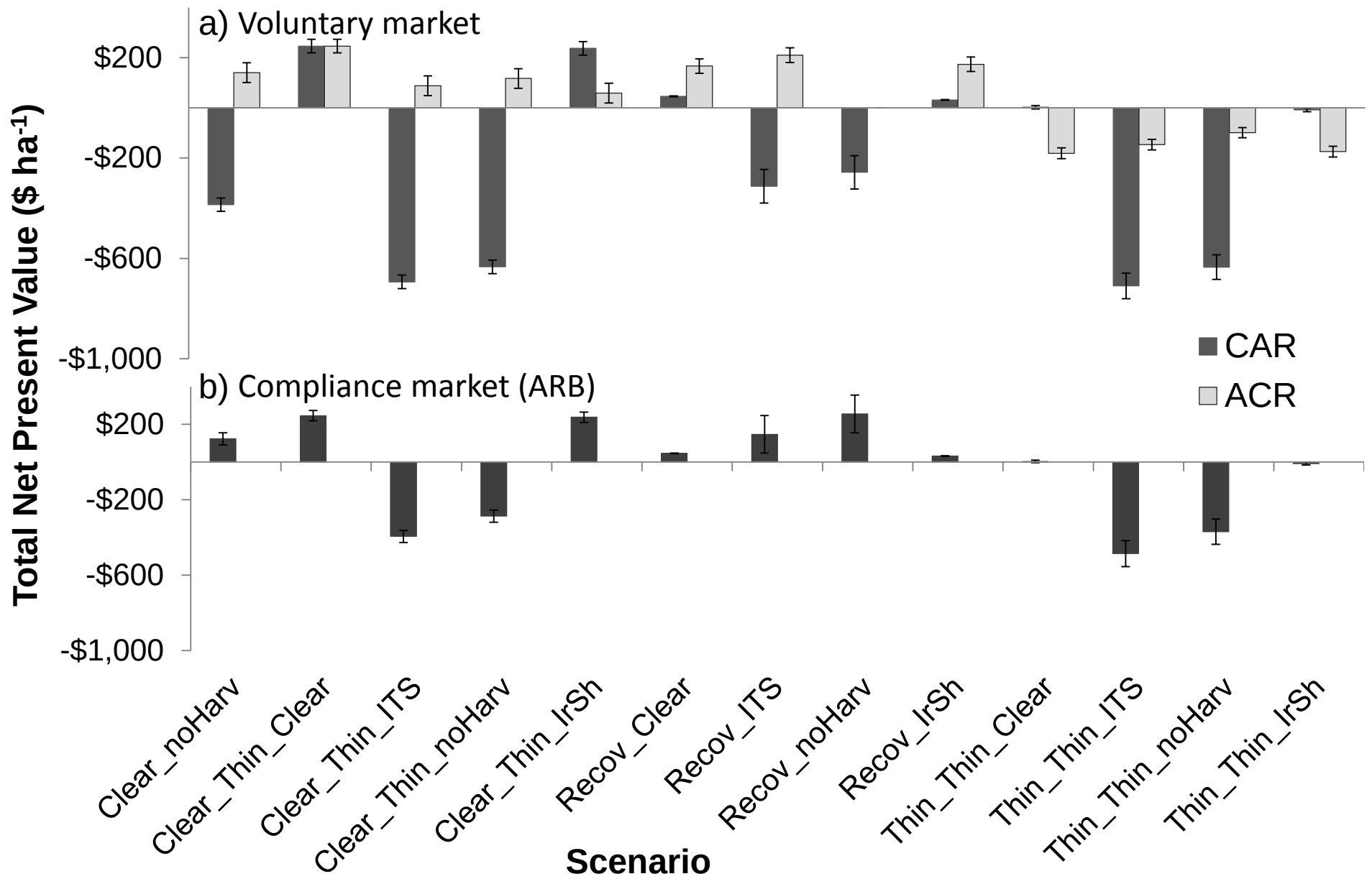
Total Carbon Credits



Offset NPV: High Price Assumptions



Total NPV: Offsets + Harvested wood



Take Home Messages

- **Lower intensity treatments recovery had the highest NPV**

- **But a range of initial rehabilitation scenarios showed potential**
  - » Silvicultural clearcuts
  - » Targeted thinning
  - » Passive initial recovery

- **NPV for carbon scenarios yielded $121-$256/ha, comparable to the NPV for timber alone.**

- **Prices must be high enough to generate net positive revenue from offsets**

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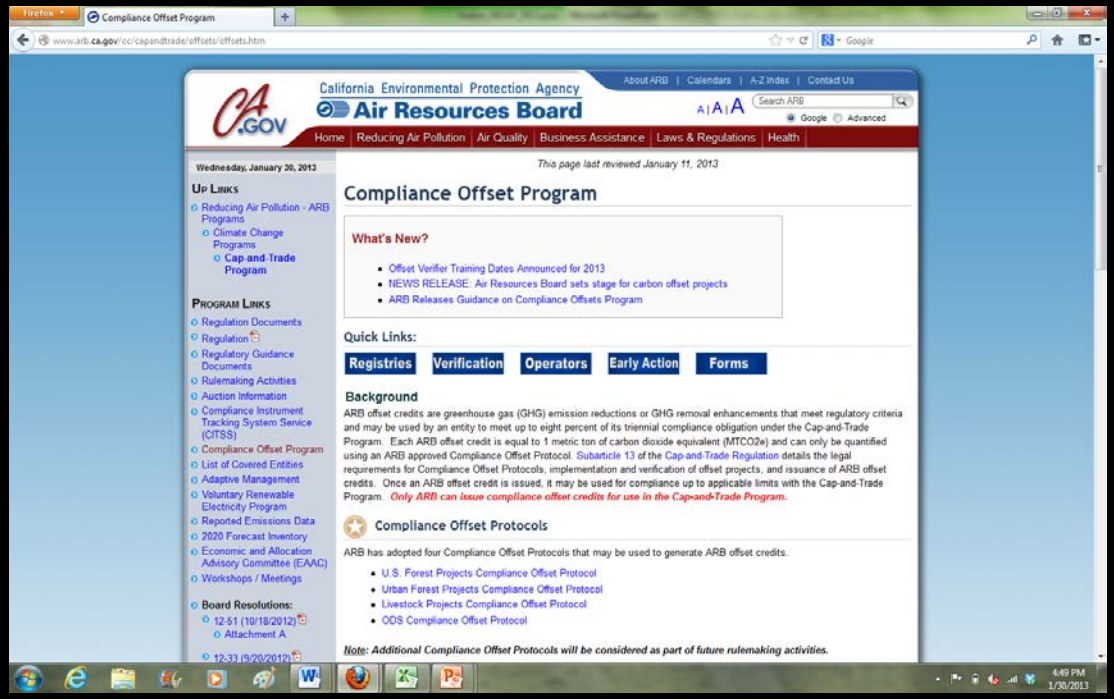
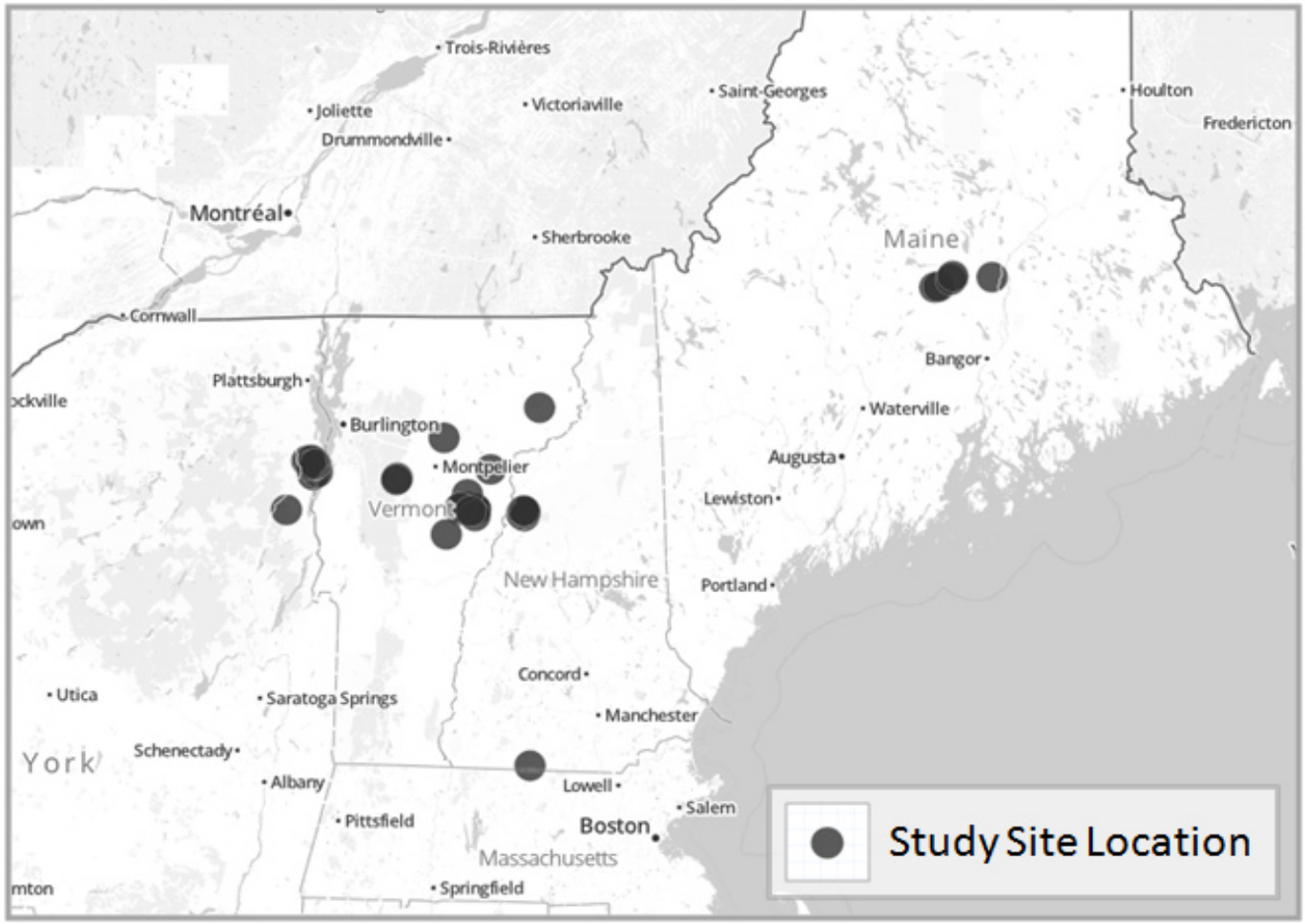
Financial Viability of Forest Carbon Projects in the Northeast

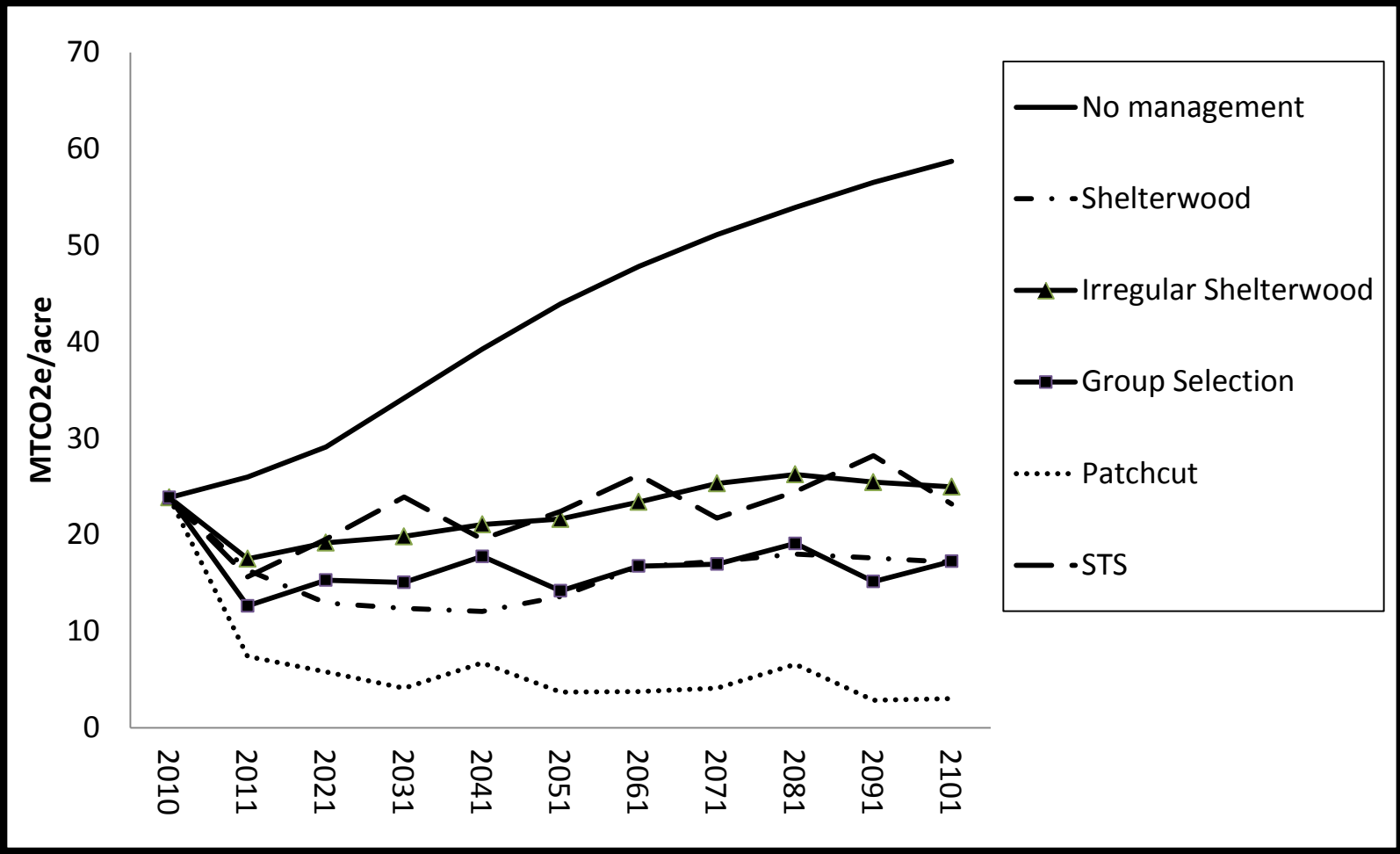
- Market price points
- Transaction Costs
- Policy Assumptions
- Economies of Scale/Property Size
- Carbon Stocking
- Other Site Characteristics



Study Sites: 25 Properties, Diverse Ownership, Size, and Management



Carbon Projections Using the Forest Vegetation Simulator: Forest C + Wood Products as per the ARB Protocol

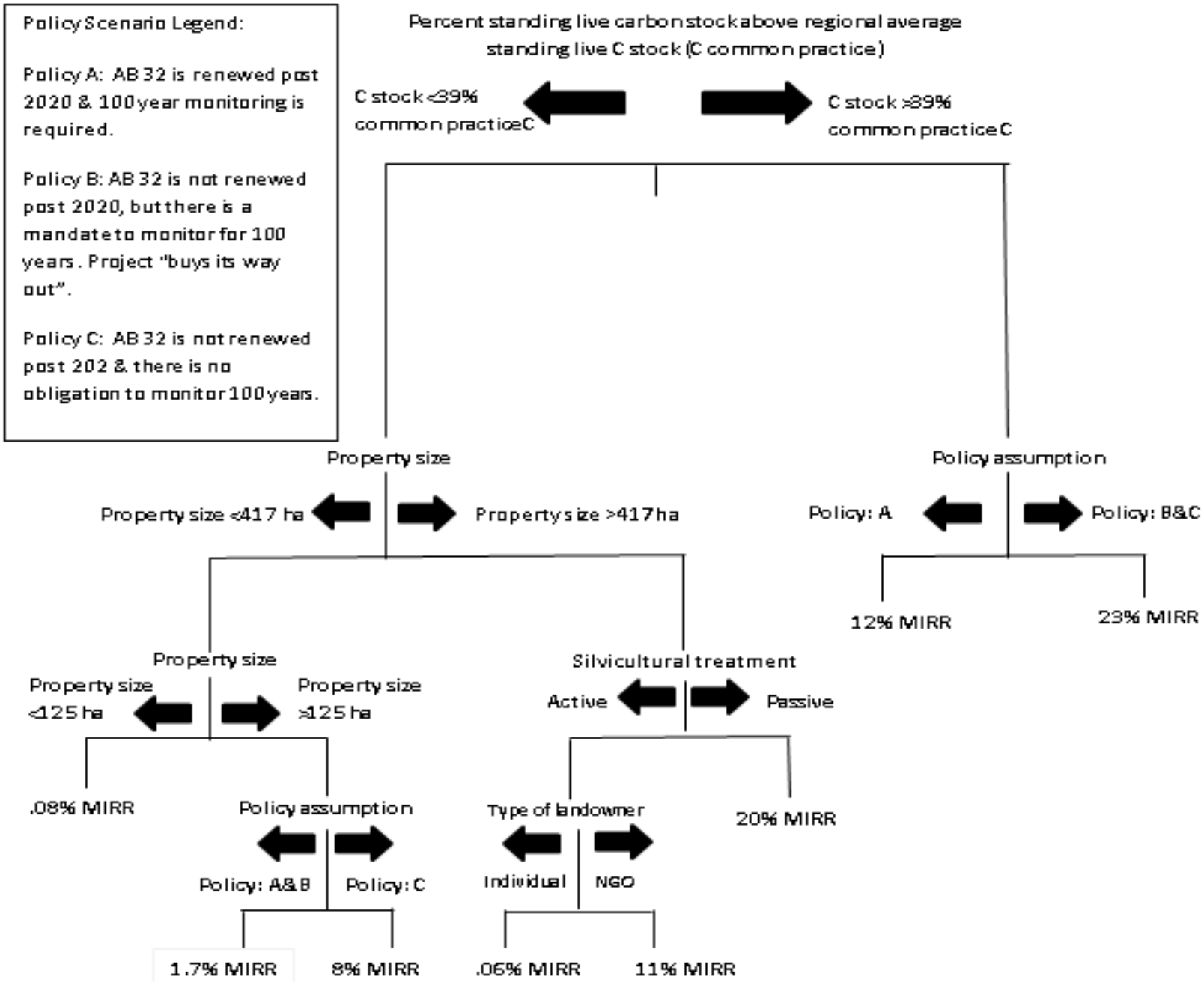


Modeled Transaction Costs

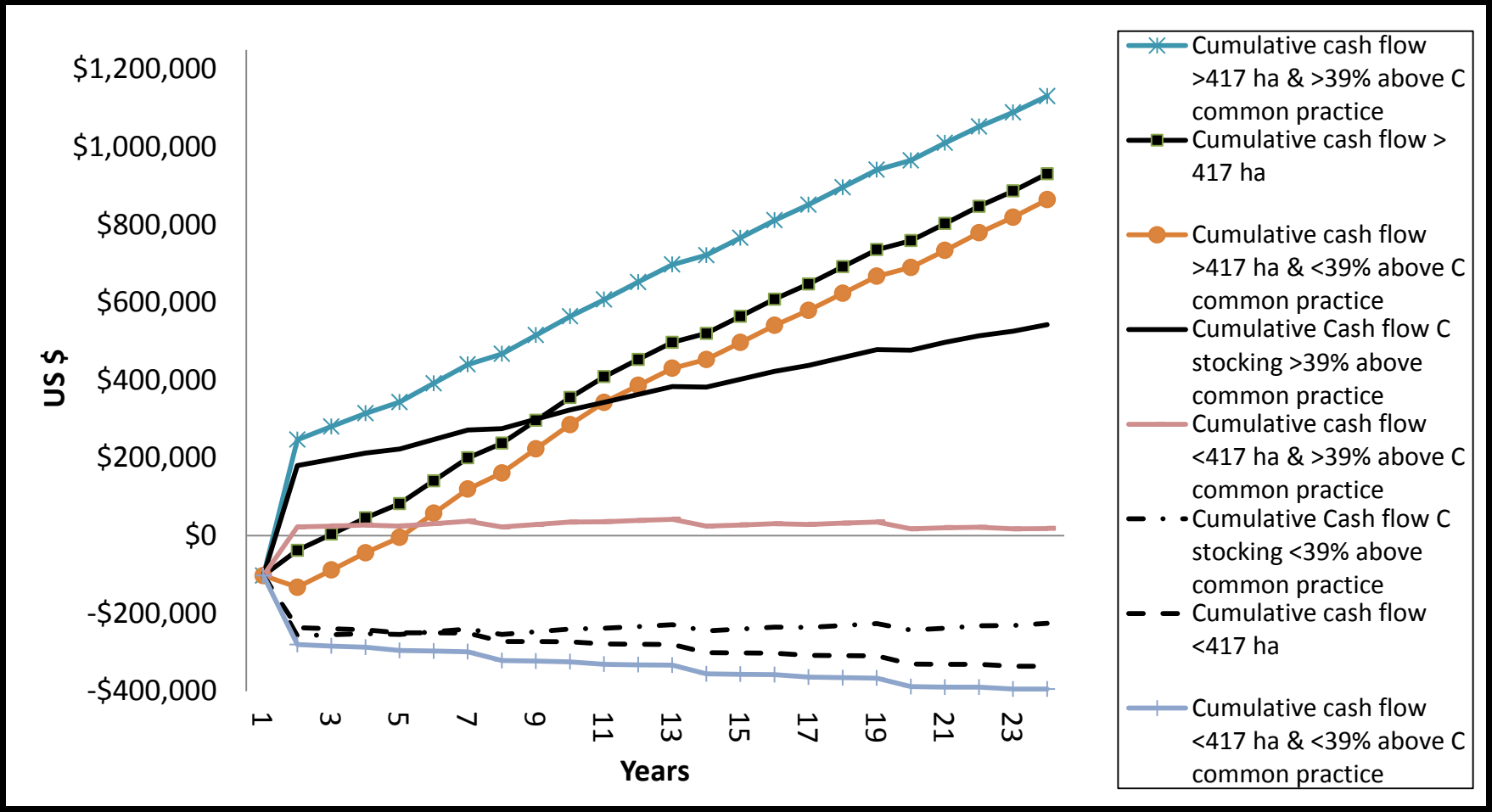
Initial development costs	Cost	Frequency
Registry opening account fee	$500	Once
Registry project listing fee	$500	Once
Labor for account opening and project listing	$1,500	Once
GIS stratification & inventory	$15,000	Once
Growth and yield modeling and C quantification	$30,000	Once
Travels costs and lodging for inventory	$3,500	Once
Project Reporting Document	$29,000	Once
Third-party verification and verification management	$25,000	Once
Total initial development costs	$105,000	Once
Monitoring Costs		
Desk review verification	$3,000	Annual
Registry fee	$500	Annual
Annual carbon accounting, modeling, monitoring & reporting	$5,000	Annual
Inventory	$12,000	Every 12 years
Onsite third-party verification	$15,000	Every six years
Other fees		
Brokerage fee	3%	
Registry credit issuance fee (cents/credit)	0.02	

Multivariate Analysis of Property Level Drivers of C Value

Independent variable	Type	Levels
% conifer	Continuous	
Site Class	Categorical	High (I-II)
		Low (III-V)
Hectares	Continuous	Numeric
% C above common practice	Continuous	Percentage
Silvicultural treatments	Categorical	No management
		Single-tree selection
		Shelterwood
		Irregular Shelterwood
		Group Selection
		Patchcut
Certification	Categorical	Yes
		No
Conservation easement	Categorical	Yes
		No
Current Use	Categorical	Yes
		No
Type of Landowner	Categorical	Land Trust/Foundation
		Private landowner
Policy Assumption	Categorical	1. ARB continues post 2020 and long-term monitoring
		2.ARB expires 2020 - "buy your way out"
		3.ARB expires 2020 - no long-term monitoring cost


Policy Scenario Legend:
Policy A: AB 32 is renewed post 2020 & 100 year monitoring is required.
Policy B: AB 32 is not renewed post 2020, but there is a mandate to monitor for 100 years. Project "buys its way out".
Policy C: AB 32 is not renewed post 202 & there is no obligation to monitor 100 years.
Percent standing live carbon stock above regional average standing live C stock (C common practice)
C stock <89% common practice C
C stock ≥89% common practice C
Property size
Property size <417 ha
Property size >417 ha
Policy assumption
Policy: A
Policy: B&C
12% MIRR
23% MIRR
Property size
Property size <125 ha
Property size ≥125 ha
.08% MIRR
Policy assumption
Policy: A&B
Policy: C
1.7% MIRR
8% MIRR
Silvicultural treatment
Active
Passive
Type of landowner
Individual
NGO
.06% MIRR
11% MIRR
20% MIRR

Cash Flows by Predictor of Financial Attractiveness



Project Viability Assessment Tool: Shelterwood Harvesting Example

	Hectares				
Scenario	200	600	1200	2400	4800
Stocking: below Common Practice Policy A	-$324,863	-$123,851	$55,277	$511,482	$1,423,815
MIRR	-3%	5%	8%	11%	14%
Stocking: >20% above common practice Policy A	-$245,642	$64,633	$530,040	$1,460,853	$3,322,480
MIRR	-100%	9%	12%	15%	18%
Stocking: >40% above common practice Policy A	-$258,153	$27,108	$454,989	$1,310,756	$3,022,278
MIRR	-100%	8%	12%	15%	18%
Stocking: below Common Practice Policy B	-$120,724	-$26,331	$57,750	$271,908	$700,219
MIRR	-16%	5%	10%	14%	16%
Stocking: >20% above Common Practice Policy B	-$58,883	$136,075	$428,508	$1,013,375	$2,183,108
MIRR	2%	15%	25%	37%	48%
Stocking: >40% above Common Practice Policy B	-$67,286	$110,865	$378,089	$912,537	$1,981,424
MIRR	3%	16%	26%	36%	47%

NPV to 2020

MIRR to 2020

Acknowledgements

- Northeastern States Research Cooperative
- USDA McIntire-Stennis Forest Research Program
- NRCS Conservation Innovation Grant